

WHAT IS CLAIMED IS:

1. A disk control apparatus connected to an information processing apparatus so as to be able to communicate with the information processing apparatus,

the disk control apparatus writing/reading data into/from

a first storage device having one or more logical volumes formed thereon,

a second storage device having one or more logical volumes formed thereon, and

a third storage device,

the disk control apparatus comprising:

a memory, association of identifiers of the logical volumes in said first storage device serving as identifiers of primary logical volumes with identifiers of the logical volumes in said second storage device serving as identifiers of secondary logical volumes being stored in said memory as a pair management table;

a timing mechanism;

a write request reception unit for receiving a write request of data for a logical volume in said first storage device and the data to be written, from the information processing apparatus;

a first write unit responsive to reception of the write request, for writing the data into the logical volume in said first storage device;

a journal write unit for writing journal data into said third storage device, the journal data

comprising an identifier of the logical volume in said first storage device into which the data has been written, information of a location in which the data is stored in the logical volume, update time which is current time acquired from said timing mechanism, and the data; and

    a second write unit for referring to the update time of the journal data stored in said third storage device, selecting journal data for which a difference between current time acquired from said timing mechanism and the update time is longer than a predetermined time, referring to an identifier of the logical volume in the journal data, the location information and the data in order of the update time in the selected journal data, acquiring an identifier of a secondary logical volume having the identifier of the logical volume as an identifier of the primary logical volume from the pair management table, and writing the data into a place indicated by the location information, in the logical volume indicated by the identifier of the secondary logical volume, in said second storage device.

2.       The disk control apparatus according to claim 1, wherein one or more hard disk drives forming said first storage device are physically separate from one or more hard disk drives forming said second storage device and said third storage device.

3.       The disk control apparatus according to claim

1, wherein

the predetermined time is stored in said memory, and

    said second write unit refers to the predetermined time stored in said memory, and selects journal data for which a difference between the update time of the journal data and current time acquired from said timing mechanism is longer than the predetermined time.

4.       The disk control apparatus according to claim 1, wherein one or more hard disk drives forming said first storage device are physically separate from one or more hard disk drives forming said second storage device.

5.       The disk control apparatus according to claim 1, comprising:

    a split ordering instruction reception unit for receiving a split ordering instruction from the information processing apparatus, the split ordering instruction interrupting writing the data into said second storage device;

    a split canceling instruction reception unit for receiving a split canceling instruction from the information processing apparatus, the split canceling instruction resuming writing the data into said second storage device;

    a split order storage unit responsive to reception of the split ordering instruction, for

writing split order data into said third storage device, the split order data comprising data indicating that the split ordering instruction has been received, and split time which is current time acquired from said timing mechanism; and

a split cancel storage unit responsive to reception of the split canceling instruction, for writing split cancel data into said third storage device, the split cancel data being data indicating that the split canceling instruction has been received,

wherein if the split order data is stored in said third storage device and the split cancel data is not stored in said third storage device, said second write unit refers to the split time in the split order data, and said second write unit does not write the data in the journal data having the update time later than the split time into said second storage device.

6. The disk control apparatus according to claim 5, wherein

virtual logical volumes which are virtual logical volumes corresponding to the logical volumes in said second storage device are provided, and association of identifiers of the logical volumes with identifiers of the virtual logical volumes is stored in said memory as a virtual logical volume management table,

the disk control apparatus comprising:  
an unreflected information storage unit for

referring to said third storage device, and responsive to the split order data being stored and the split cancel data being not stored, for storing unreflected information in said memory, the unreflected information comprising an identifier of the logical volume in the journal data having the update time earlier than the split time in the split order data, and the location information;

a read request reception unit for receiving a read request of data having an identifier of the virtual logical volume and location information set therein, from the information processing apparatus;

an identifier acquisition unit for acquiring an identifier of the logical volume in said second storage device corresponding to the identifier of the virtual logical volume in the read request from said virtual logical volume management table;

an overlapping range acquisition unit for referring to the unreflected information stored in said memory, comparing, in the unreflected information for which the identifier of the logical volume in said second storage device acquired by said identifier acquisition unit is the same as an identifier of the logical volume in the unreflected information, a range indicated by the location information set in the read request with a range indicated by the location information in the unreflected information, and thereby acquiring an overlapping range;

a virtual logical volume read unit, as for the overlapping range in the range indicated by the location information set in the read request, said virtual logical volume read unit reading the data in the journal data stored in said third storage device, and as for a range other than the overlapping range in the range indicated by the location information set in the read request, said virtual logical volume read unit reading the data stored in the logical volume indicated by the identifier of the logical volume in said second storage device acquired by said identifier acquisition unit; and

a read data transmission unit for transmitting the data read by said virtual logical volume read unit to the information processing apparatus.

7. The disk control apparatus according to claim 5, wherein if the split order data is stored in said third storage device and the split cancel data is not stored in said third storage device, said second write unit writes the data in the journal data having the update time earlier than the split time into said second storage device irrespective of whether the difference between the current time acquired by said timing mechanism and the update time is longer than the predetermined time.

8. The disk control apparatus according to claim 1, wherein

the logical volumes in said first storage device are provided with group IDs, and association of the identifiers of the logical volumes with the group IDs is stored in said memory as a group ID management table,

    said journal write unit acquires the group ID corresponding to the identifier of the logical volume in which the data is written in said first storage device, from said group ID management table, sets the group ID in the journal data, and writes the journal data into said third storage device,

    the disk control apparatus comprises:

    a split ordering instruction reception unit for receiving a split ordering instruction from the information processing apparatus, the split ordering instruction interrupting writing the data into said second storage device;

    a split canceling instruction reception unit for receiving a split canceling instruction from the information processing apparatus, the split canceling instruction resuming writing the data into said second storage device;

    a split order storage unit responsive to reception of the split ordering instruction, for writing split order data into said third storage device, the split order data comprising the group ID set in the split ordering instruction, data indicating that the split ordering instruction has been received,

and split time which is current time acquired from said timing mechanism; and

a split cancel storage unit responsive to reception of the split canceling instruction, for writing split cancel data into said third storage device, the split cancel data comprising the group ID set in the split canceling instruction, and data indicating that the split canceling instruction has been received,

wherein if the split order data is stored in said third storage device and the split cancel data having the same group ID as the group ID in the split order data, set therein is not stored in said third storage device, said second write unit refers to the group ID and the split time in the split order data, and said second write unit does not write the data in the journal data having the same group ID as the group ID in the split order data and having the update time later than the split time into said second storage device.

9. The disk control apparatus according to claim 8,

wherein virtual logical volumes which are virtual logical volumes corresponding to the logical volumes in said second storage device are provided, and association of identifiers of the logical volumes with identifiers of the virtual logical volumes is stored in said memory as a virtual logical volume management

table,

the disk control apparatus comprising:  
an unreflected information storage unit for  
referring to said third storage device, and responsive  
to the split order data being stored in said third  
storage device and the split cancel data having the  
same group ID as the group ID in the split order data,  
set therein being not stored in said third storage  
device, for storing unreflected information in said  
memory, the unreflected information comprising an  
identifier of the logical volume in the journal data  
having the same group ID as the group ID in the split  
order data, set therein and having the update time  
earlier than the split time in the split order data,  
and the location information;

a read request reception unit for receiving a  
read request of data having an identifier of the  
virtual logical volume and location information set  
therein, from the information processing apparatus;

an identifier acquisition unit for acquiring  
an identifier of the logical volume in said second  
storage device corresponding to the identifier of the  
virtual logical volume in the read request from said  
virtual logical volume management table;

an overlapping range acquisition unit for  
referring to the unreflected information stored in said  
memory, comparing, in the unreflected information for  
which the identifier of the logical volume in said

second storage device acquired by said identifier acquisition unit is the same as an identifier of the logical volume in the unreflected information, a range indicated by the location information set in the read request with a range indicated by the location information in the unreflected information, and thereby acquiring an overlapping range;

a virtual logical volume read unit, as for the overlapping range in the range indicated by the location information set in the read request, said virtual logical volume read unit reading the data set in the journal data stored in said third storage device, and as for a range other than the overlapping range in the range indicated by the location information set in the read request, said virtual logical volume read unit reading the data stored in the logical volume indicated by the identifier of the logical volume in said second storage device acquired by said identifier acquisition unit; and

a read data transmission unit for transmitting the data read by said virtual logical volume read unit to the information processing apparatus.

10. The disk control apparatus according to claim 8, wherein if the split order data is stored in said third storage device and the split cancel data having the same group ID as the group ID in the split order data, set therein is not stored in said third storage

device, said second write unit writes the data in the journal data having the same group ID as the group ID in the split order data and having the update time earlier than the split time into said second storage device irrespective of whether the difference between the current time acquired by said timing mechanism and the update time is longer than the predetermined time.

11. A control method for a disk control apparatus connected to an information processing apparatus so as to be able to communicate with the information processing apparatus,

the disk control apparatus writing/reading data into/from

a first storage device having one or more logical volumes formed thereon,

a second storage device having one or more logical volumes formed thereon, and

a third storage device,

the disk control apparatus comprising:

a memory, association of identifiers of the logical volumes in said first storage device serving as identifiers of primary logical volumes with identifiers of the logical volumes in said second storage device serving as identifiers of secondary logical volumes being stored in said memory as a pair management table; and

a timing mechanism,

the control method comprising the steps of:

receiving a write request of data for a logical volume in said first storage device and the data to be written, from the information processing apparatus;

upon receiving the write request, writing the data into the logical volume in said first storage device;

writing journal data into said third storage device, the journal data comprising an identifier of the logical volume in said first storage device into which the data has been written, information of a location in which the data is stored in the logical volume, update time which is current time acquired from said timing mechanism, and the data; and

referring to the update time of the journal data stored in said third storage device, selecting journal data for which a difference between current time acquired from said timing mechanism and the update time is longer than a predetermined time, referring to an identifier of the logical volume in the journal data, the location information and the data in order of the update time in the journal data, acquiring an identifier of a secondary logical volume having the identifier of the logical volume as an identifier of the primary logical volume from the pair management table, and writing the data into a place indicated by the location information, in the logical volume indicated by the identifier of the secondary logical

volume, in said second storage device.

12. The control method for disk control apparatus according to claim 11, comprising the steps of:

receiving a split ordering instruction from the information processing apparatus, the split ordering instruction interrupting writing the data into said second storage device;

receiving a split canceling instruction from the information processing apparatus, the split canceling instruction resuming writing the data into said second storage device;

upon receiving the split ordering instruction, writing split order data into said third storage device, the split order data comprising data indicating that the split ordering instruction has been received, and split time which is current time acquired from said timing mechanism; and

upon receiving the split canceling instruction, writing split cancel data into said third storage device, the split cancel data being data indicating that the split canceling instruction has been received,

wherein the step of writing the update data stored in said third storage device into the logical volume in said second storage device is a step in which if the split order data is stored in said third storage device and the split cancel data is not stored in said third storage device, the split time in the split order

data is referred to, and the data in the journal data having the update time later than the split time is not written into said second storage device.

13. The control method for disk control apparatus according to claim 12,

wherein virtual logical volumes which are virtual logical volumes corresponding to the logical volumes in said second storage device are provided, and association of identifiers of the logical volumes with identifiers of the virtual logical volumes is stored in said memory as a virtual logical volume management table,

the disk control apparatus comprising the steps of:

referring to said third storage device, and responsive to the split order data being stored and the split cancel data being not stored, storing unreflected information in said memory, the unreflected information comprising an identifier of the logical volume in the journal data having the update time earlier than the split time in the split order data, and the location information;

receiving a read request of data having an identifier of the virtual logical volume and location information set therein, from the information processing apparatus;

acquiring an identifier of the logical volume in said second storage device corresponding to the

identifier of the virtual logical volume in the read request from said virtual logical volume management table;

referring to the unreflected information stored in said memory, comparing, in the unreflected information for which the identifier of the logical volume in said second storage device acquired by said identifier acquisition unit is the same as an identifier of the logical volume in the unreflected information, a range indicated by the location information set in the read request with a range indicated by the location information in the unreflected information, and thereby acquiring an overlapping range;

as for the overlapping range in the range indicated by the location information set in the read request, reading the data in the journal data stored in said third storage device, and as for a range other than the overlapping range in the range indicated by the location information set in the read request, reading the data stored in the logical volume indicated by the identifier of the logical volume in said second storage device acquired by said identifier acquisition unit; and

transmitting the data read at said data reading step to the information processing apparatus.

14. The control method for disk control apparatus according to claim 12, wherein the step of writing the

update data stored in said third storage device into the logical volume in said second storage device is a step in which if the split order data is stored in said third storage device and the split cancel data is not stored in said third storage device, the data in the journal data having the update time earlier than the split time is written into said second storage device irrespective of whether the difference between the current time acquired by said timing mechanism and the update time is longer than the predetermined time.

15. The control method for disk control apparatus according to claim 11, wherein

the logical volumes in said first storage device are provided with group IDs, and association of the identifiers of the logical volumes with the group IDs is stored in said memory as a group ID management table,

the step of writing the journal data into said third storage device is a step of acquiring the group ID corresponding to the identifier of the logical volume in which the data is written in said first storage device, from said group ID management table, setting the group ID in the journal data, and writing the journal data into said third storage device,

the control method comprising the steps of: receiving a split ordering instruction from the information processing apparatus, the split ordering instruction interrupting writing the data into

said second storage device;

    receiving a split canceling instruction from the information processing apparatus, the split canceling instruction resuming writing the data into said second storage device;

    upon receiving the split ordering instruction, writing split order data into said third storage device, the split order data comprising the group ID set in the split ordering instruction, data indicating that the split ordering instruction has been received, and split time which is current time acquired from said timing mechanism; and

    upon receiving the split canceling instruction, writing split cancel data into said third storage device, the split cancel data comprising the group ID set in the split canceling instruction, and data indicating that the split canceling instruction has been received,

    wherein the step of writing the update data stored in said third storage device into the logical volume in said second storage device is a step in which if the split order data is stored in said third storage device and the split cancel data having the same group ID as the group ID in the split order data, set therein is not stored in said third storage device, the group ID and the split time in the split order data is referred to, and the data in the journal data having the same group ID as the group ID in the split order

data and having the update time later than the split time is not written into said second storage device.

16. The control method for disk control apparatus according to claim 15,

wherein virtual logical volumes which are virtual logical volumes corresponding to the logical volumes in said second storage device are provided, and association of identifiers of the logical volumes with identifiers of the virtual logical volumes is stored in said memory as a virtual logical volume management table,

the control method comprising the steps of: referring to said third storage device, and responsive to the split order data being stored in said third storage device and the split cancel data having the same group ID as the group ID in the split order data, set therein being not stored in said third storage device, storing unreflected information in said memory, the unreflected information comprising an identifier of the logical volume in the journal data having the same group ID as the group ID in the split order data, set therein and having the update time earlier than the split time in the split order data, and the location information;

receiving a read request of data having an identifier of the virtual logical volume and location information set therein, from the information processing apparatus;

acquiring an identifier of the logical volume in said second storage device corresponding to the identifier of the virtual logical volume in the read request from said virtual logical volume management table;

referring to the unreflected information stored in said memory, comparing, in the unreflected information for which the identifier of the logical volume in said second storage device acquired by said identifier acquisition unit is the same as an identifier of the logical volume in the unreflected information, a range indicated by the location information set in the read request with a range indicated by the location information in the unreflected information, and thereby acquiring an overlapping range;

as for the overlapping range in the range indicated by the location information set in the read request, reading the data set in the journal data stored in said third storage device, and as for a range other than the overlapping range in the range indicated by the location information set in the read request, reading the data stored in the logical volume indicated by the identifier of the logical volume in said second storage device acquired by said identifier acquisition unit; and

transmitting the data read at said data reading step to the information processing apparatus.

17. The control method for disk control apparatus according to claim 15, wherein the step of writing the update data stored in said third storage device into the logical volume in said second storage device is a step in which if the split order data is stored in said third storage device and the split cancel data having the same group ID as the group ID in the split order data, set therein is not stored in said third storage device, the data in the journal data having the same group ID as the group ID in the split order data and having the update time earlier than the split time is written into said second storage device irrespective of whether the difference between the current time acquired by said timing mechanism and the update time is longer than the predetermined time.

18. A disk control apparatus connected to an information processing apparatus so as to be able to communicate with the information processing apparatus, the disk control apparatus writing/reading data into/from

a first storage device comprising one or more hard disk drives,

a second storage device comprising one or more hard disk drives, and

a third storage device comprising one or more hard disk drives,

one or more logical volumes being formed in said first storage device,

one or more logical volumes being formed in said second storage device,

the disk control apparatus comprising:

a channel control unit for receiving a data write request for the logical volume from the information processing apparatus;

a disk control unit for writing the data received by said channel control unit into the logical volume; and

a switching control unit for connecting said channel control unit, said disk control unit and said shared memory so as to be capable of conducting communication;

wherein association of identifiers of the logical volumes in said first storage device serving as identifiers of primary logical volumes with identifiers of the logical volumes in said second storage device serving as identifiers of secondary logical volumes is stored in said memory as a pair management table;

wherein said disk control unit comprises:

a journal write unit responsive to the data being written into the logical volume in said first storage device consequent upon the write request received from said channel control unit, for writing journal data into said third storage device, the journal data comprising an identifier of the logical volume in said first storage device into which the data has been written, information of a location in which

the data is stored in the logical volume, update time which is current time acquired from said timing mechanism, and the data; and

a second write unit for referring to the update time of the journal data stored in said third storage device, selecting journal data for which a difference between current time acquired from said timing mechanism and the update time is longer than a predetermined time stored in said shared memory, referring to an identifier of the logical volume in the journal data, the location information and the data in order of the update time in the selected journal data, acquiring an identifier of a secondary logical volume having the identifier of the logical volume as an identifier of the primary logical volume from the pair management table, and writing the data into a place indicated by the location information, in the logical volume indicated by the identifier in the secondary logical volume, in said second storage device.